I. PIGMENTS IN HYBRID CORN AND THEIR SUSCEPTIBILITY TO BLEACHING.

II. THE MINERAL CONSTITUENTS OF FORAGE CROPS.

BY

ADOLPH ROBERT JENSEN

B.S., Wheaton College, 1937

M.S., University of Illinois, 1940

AN ABSTRACT OF A THESIS

SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN
CHEMISTRY IN THE GRADUATE SCHOOL OF
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ACKNOWLEDGMENT

The author wishes to express his appreciation to Professor Duane T. Englis for his cheerful criticism and guidance in this investigation.

PART I.

PIGMENTS IN HYBRID CORN AND THEIR SUSCEPTIBILITY TO BLEACHING

INTRODUCTION

During an exhibition of several types of hybrid corn on a testing plot at one of the experimental fields of the Department of Agronomy of the University of Illinois, it was noted that one variety of yellow hybrid corn was markedly bleached upon exposure to sunlight, while another variety was not noticeably affected.

Since yellow corn is known to have a vitamin A value due to its cryptoxanthin content[7] and since many swine producers consider that it is the main source of vitamin A in the ration, the bleaching action was thought to be significant.

In this investigation an attempt was made to discover the nature and the extent of the chemical changes in the pigments during bleaching. The first step required the development of an analytical method for quantitatively following the changes of the pigments especially those of provitamin significance.

EXPERIMENTAL

The separation of the pigments is based upon their differential solubilities in methyl alcohol and petroleum ether[3].

In determining the cryptoxanthin-carotene content[1] the sample of corn was ground in a ball mill and then alkali was added to saponify the carotenoid esters. The sample was extracted with a mixture of high boiling petroleum ether and methyl alcohol since the cryptoxanthin-carotene is more soluble in the petroleum ether while the zeaxanthin is more soluble in methyl alcohol. The petroleum ether extract was reduced to a small volume by vacuum distillation and the color was measured by means of a Cenco Spectrophotelometer[4] which indicates the amount of light absorbed by a sample from a band of essentially mono-chromatic light. A similar procedure was employed to determine the zeaxanthin.

The use of carbon dioxide during the grinding process reduced the loss of pigment and also permitted the storage of ground samples with no loss of pigment. Samples stored for twenty days in brown bottles from which the air had been removed and replaced by carbon dioxide showed no change in cryptoxanthin-carotene content.

The optimum hydrolysis time for the corn extraction was found to be about one hour.

A Wiley mill was successfully substituted for the lengthy ball mill process. This reduced the time of grinding from ten hours to about thirty minutes and reduced the loss of pigments in the process.

The amount of cryptoxanthin varied from 5.0 gamma per gram of corn in the susceptible hybrid, Pioneer 335, to 4.4 gamma per gram of corn in the resistant hybrid, Pioneer 324.

Upon exposure to light, the unground samples of the resistant variety showed no reduction of pigment while the susceptible variety showed a reduction of from 5.0 gamma per gram to 4.0 gamma per gram.

When the corn was ground before exposure, the loss of pigment was from 4.4 to 3.3 gamma per gram in the case of the resistant sample and from 5.0 to 3.7 gamma per gram in the case of the susceptible sample.

In a comparison of the resistance of hybrids to bleaching, Pioneer 324 showed the greatest resistance to sunlight and water. All the others showed some destruction of pigment.

PART II.

THE MINERAL CONSTITUENTS OF FORAGE CROPS

INTRODUCTION

Analytical methods of analysis for mineral constituents of plants are very important in the study of plant and animal metabolism. Very nearly all of the elements in the periodic table have been found in plant or animal tissues. Whether some of these are present as mere accidental traces or because of actual physiological need, is the present problem of plant and animal physiologists and biochemists.

The Horse and Mule Association of America has been interested in knowing the composition of samples of forage from various grazing areas in the United States. Some of these areas are noted for the production of fine healthy animals while others are characterized by different soil types and climatic conditions which produce a forage of apparent deficient nutritive value for the animals.

At the request of the Secretary of the Association, Mr. Wayne Dinsmore, this investigation was undertaken, the object of which was to determine some of the more essential elements in the forage crops and particularly to study the application of some of the newer methods and equipment for the estimation of some of the trace elements. The samples were supplied by the Secretary with the cooperation of numerous members of the association and the areas represented range from the Blue Grass Region of Kentucky to the arid plains of Texas and New Mexico.

EXPERIMENTAL

Representative portions of the samples were prepared for analysis by grinding in a Wiley mill and destroying the organic matter by a modified perchloric acid-nitric acid digestion.[5] This gave a very satisfactory product, the silica having become dehydrated and easily removed by filtration.

Calcium and phosphorus were determined by official methods, namely, by the separation of the calcium as the oxalate and the titration of the oxalic acid with standard perman-

ganate solution and the separation of phosphorus as the phosphomolybdate, solution in excess standard alkali and back titration with standard acid.

The results of the investigation with reference to the nutritive aspect of the problem will be discussed in a bulletin of the association.

Iron was determined colorimetrically by a method using o-phenanthroline[2] to complex the ferrous ion and measuring the intensity at 510 mu with a Cenco Spectrophotelometer. Values for iron ranged from 20 to 340 p.p.m. of the air-dried samples. The method gave good results in all but a very few cases. In these few samples the colored complex appeared to be precipitated when the solution stood for some time. An explanation of this difficulty has not yet been worked out.

A comparison has been made of the direct ignition and the "wet ashing" processes with reference to the iron content of certain samples high in silica. The latter method gave much higher results indicating a probable retention of iron in the residue after direct ignition and suggests the need for further critical examination of the "dry ashing" method.

Manganese was determined colorimetrically[6] by conversion to the permanganate ion with potassium periodate and measurement of intensity of color with the Cenco Spectrophotelometer at 530 mu. No difficulty was encountered with any of the samples and the results were very satisfactory. The range of concentration was from 10 to 190 p.p.m.

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VITA

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